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Hooded seal, Cystophora cristata, feeding and interactions with commercial fisheries in Newfoundland

by

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Abstract

Concern over the potential impact of hooded seals (Cystophora cristata) on commercial fisheries has increased in recent years. The primary reasons for this are the assumed increase in abundance since the end of the large-vessel hunt in 1983 and the perception that seals eat a substantial amount of commercially important fish daily. This paper reviews existing knowledge of hooded seal diets, presents the results of the first quantitative examination of hooded seal stomachs in the Newfoundland area, and indicates areas where interaction between hooded seals and commercial fisheries may occur. Between 1982 and 1990, 201 hooded seal stomachs were collected by DFO research personnel or through a shore-based collector program involving sealers and fishermen. Species composition of diet was reconstructed by examining stomach contents and identifying remains recovered using a sieve-water bath technique. Of 89 stomachs containing food, the most frequently occurring species were Greenland halibut (53.9%), Arctic cod (27.0%), capelin (23.6%), squid (19.1%), herring (13.5%) and redfish (11.2%). Unidentified fish were found in 9.0% of the stomachs examined. Of these important prey species, Greenland halibut, capelin, herring and redfish are also commercially harvested by Canadian fisheries. Due to lack of knowledge concerning hooded seal distribution in relation to prey species and food requirements, the extent of possible interactions with commercial fisheries cannot be estimated.

Résumé

Depuis quelques années, on s'inquiète de plus en plus des effets possibles des phoques à capuchon (Cystophora cristata) sur les pêches commerciales. Ce phénomène est dû essentiellement à l'accroissement présumé de l'abondance de ce phoque depuis la fin de la chasse par les gros navires en 1983 et au fait qu'on le rend responsable de la consommation quotidienne d'une grande quantité de poissons à valeur commerciale. Le présent document décrit les connaissances dont on dispose au sujet de l'alimentation du phoque à capuchon, présente les résultats des premiers examens quantitatif d'estomacs de phoque à capuchon de la région de Terre-Neuve et expose les possibilités d'interaction entre cet animal et les pêches commerciales. Entre 1982 et 1990, 201 estomacs de phoque à capuchon ont été recueillis soit par des scientifiques du MPO, soit par des pêcheurs ou par des chasseurs de phoque dans le cadre d'un programme de collecte à terre. On a pu établir la composition de la nourriture consommée en examinant le contenu de ces estomacs et en identifiant les restes d'aliments qu'on y trouvait au moyen d'une technique de bain et tamisage. Les espèces les plus courantes dans les 89 estomacs qui contenaient des aliments étaient le flétan du Groenland (53,9 %), la morue arctique (27,0 %), le capelan (23,6 %), l'encornet (19,1 %), le hareng (13,5 %) et le sébaste (11,2 %). De plus, 9 % des estomacs examinés contenaient du poisson non identifié. Parmi les principales espèces qui ont été la proie du phoque à capuchon, le flétan du Groenland, le capelan, le hareng et le sébaste en sont quatre qui sont exploitées commercialement par les pêcheurs canadiens. Faute de connaissances sur la distribution et les besoins énergétiques du phoque à capuchon, il est impossible d'estimer l'ampleur de ses interactions possibles avec les pêches commerciales.

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Introduction

The role of the hooded seal (Cystophora cristata) in the northwest Atlantic ecosystem and its possible interaction with commercial fisheries is not well known. Historically, commercial catches of hooded seals in western Atlantic waters surrounding Newfoundland were high, reaching a peak of 62,000 in 1901. The average numbers of commercially harvested hooded seal pups at the whelping patch off Newfoundland between 1965 and 1982 ranged from 5,000 to 12,000, with total hooded seal catches estimated at 10,250 to 15,600 during this period. After the end of the large vessel hunt in 1983, catches dropped dramatically, ranging from 30 to 1,400 between 1983 and 1990. Along with the reduced annual seal harvest, recent reductions in fishing quotas (particularly northern cod) has resulted in the popular perception that increasing seal abundance is adversely affecting commercial fish stocks.

The objectives of this paper are to a) review the existing knowledge of hooded seal diets, b) present the results of stomach content analyses for animals collected between 1982 and 1990 off the coast of Newfoundland and c) indicate potential interactions between hooded seals and commercial fisheries.

Biology of Hooded Seals

Hooded seals are the largest of the northern phocids. Males reach a length of about 3 m and weigh on average approximately 300 kg, while the females are slightly smaller at 2.4 m and less than 200 kg (Mansfield 1967, Kovacs and Lavigne 1986). The energy requirements of hooded seals have been previously estimated (Elias 1985, Bowen et al. 1987a). Although these studies provide valuable information, they are limited in time, to specific age classes, and/or laboratory settings. Based upon studies of other phocids, the Royal Commission estimates that these seals consume aproximately 4% of their body weight per day (Royal Commission 1986).

Hooded seals are thought to be primarily offshore animals that prefer deep water and thick, drifting ice flows of the north Atlantic and Arctic seas. Three populations are recognized, based on whelping concentrations in March or early April. The largest of these whelps in the northwest Atlantic, off the coast of northern Newfoundland (Front) and in the Gulf of St. Lawrence (Gulf). A second concentration occurs at approximatley 64°N in the Davis Strait between Greenland and Canada (Sergeant 1974, Bowen et al. 1987b), while the third breeds in the eastern Atlantic near the island of Jan Mayen (71°N, 8°W), east of Greenland.

Although hooded seals whelp in separate areas, stock delineations are not clear, especially between the Front, Gulf and Davis Strait groups. Tag returns from hunters indicate that, following the whelping period, hooded seals from the Gulf, Front and Davis Strait herds move to Greenland, eventually reaching the Denmark Strait (66-68°N) where they moult during late June or July. The Jan Mayen animals appear to form a separate moulting patch in northeast Greenland (72-74°N). On completion of moulting the populations disperse. At least some of the Denmark Strait moulting population moves south and west around Cape Farewell, and north along the coast of West Greenland as far north as the Thule district (Kapel 1975). Autumn and winter distribution of hooded seals in Canadian waters is poorly known, but winter sightings have been reported on the Grand Banks off Newfoundland (Rasmussen 1960). Hooded seals are also known to be caught incidentally in fishing gear off Labrador and northeastern Newfoundland during January and February (Stenson, unpublished data).

Populations

Estimates of pup production at the Front, based on the survival index method and sequential population analysis, ranged from 25,000 to 40,000 for the period 1966-1978 (Øritsland and Benjaminsen 1975, Sergeant 1976b, Winters and Bergflodt 1978). Pup production was estimated by aerial surveys of the Front and Davis Strait in 1984 (Bowen et al. 1987b), at the Front in 1985 (Hay et al. 1985) and at the Front and Gulf in 1990 (Stenson et al. 1991). The 1984 surveys estimated pup production in the Davis Strait to be 18,600 (95% CI 14,000 - 23,000). After correcting for the distribution of births, production at the Front was estimated to be 62,400 (95% CI 43,700 - 89,000). Although the 1985 survey was not corrected for the temporal distribution of births, the estimate of 61,400 pups (95% C.I. 16,496 - 119,456) at the Front supports the 1984 estimate and indicates that pup production at the Front is considerably greater than previously thought. The results of the 1990 surveys suggest that pup production is currently in the order of 80,000 at the Front and 1,500 in the Gulf (Stenson et al. 1991, Hammill unpublished data).

It is difficult to estimate the total population of hooded seals in the northwest Atlantic. If you assume a ratio of pups to seals aged 1 and over (1+) of 1:4 as seen in harp seals (Roff and Bowen 1983) the total population is estimated to be approximately 300,000. The proportion of this number actually present in Canadian waters at any given time is unknown.

Food of Hooded Seals

Due to their offshore distribution, quantitative data on the feeding behaviour and dietary preferences of hooded seals is sparse (Sergeant 1976b). Kapel (1982) compiled data on the stomach contents of juvenile and adult hooded seals (ages 0-20+ years) collected from south, southeast and northwest Greenland between 1970 and 1978. Stomachs were collected and contents determined by hunters. Of the total 2,086 seal stomachs reported, 1,341 (64%) contained food. In all three areas, fish comprised the majority of prey items found (Table 1). The most commonly identified prey species found in the stomachs from south Greenland were unidentified Gadoids and redfish (Sebastes spp); from southeast Greenland, redfish; and from northwest Greenland, Greenland halibut (Reinhardtius hippoglossoides).

Sergeant (1976b) provided qualitative information on the food of hooded seals in the northwest Atlantic. He reported that hooded seals feed on larger food organisms including squid (Gonatus fabricii) and redfish , although no details are given concerning location of samples or number of seals examined. In a review, Reeves and Ling (1981) compiled a list of prey species, including squid, redfish, octopus (Octopodea), capelin (Mallotus villosus), herring (Clupea harengus), Atlantic cod (Gadus morhua), Greenland halibut, shrimps (Natantia), mussels (Mytylus sp.), and starfish (Asteroidea).

Methods

To examine the food habits of hooded seals in Newfoundland and Labrador, stomachs were collected between 1982 and 1990 by Department of Fisheries and Oceans (DFO) personnel directly or obtained from fishermen and sealers through a shore-based collector program. The age of each seal was determined by counting annual growth layers in the cementum and dentine of teeth (Bowen, et al. 1983, Lydersen & Gjertz 1988).

Following collection, samples were stored in 70% ethanol until analyzed. In the laboratory, stomachs were opened longitudinally along the greater curvature and the contents washed into a large tray where they were manually sorted into categories of prey species to the lowest taxonomic level. Indentification keys, reference collections and descriptions were used to identify all undigested prey items. Standard length of fish or carapace of crustaceans were measured when possible. Loose otoliths in the stomach were recovered using a sieve-water-bath technique (Murie and Lavigne 1985). Recovered skull cases were examined for the presence or absence of sagittal otoliths. Numbers of invertebrates were estimated using numbers of whole specimens, carapaces, and squid beaks.

The frequency of occurrence of each prey type and estimated numbers of individuals were determined for each stomch examined.

Results

A total of 201 hooded seals stomachs were collected, 94 (46.8%) of which were taken from males and 107 (53.2%) from females. Seal pups (< 1 year of age) accounted for 27% of the total stomachs examined. Samples were collected between January and September with the majority (84.6%) obtained in March and April (Table 2).

Sampling locations were grouped into five different regions; the nearshore waters along the northeast coast of Newfoundland, offshore waters (NAFO area 2J3KL), Labrador, the south coast of Newfoundland, and the whelping patch on the Front. The majority of stomachs (71.1%) came from the nearshore region along the northeast coast of Newfoundland (Table 2). This area accounted for 94.5% (n=52) of the pup samples and 62.3% (n=91) of the 1+ animals (Table 3).

Of the 201 stomachs examined, 55.7% of them were empty (66 females and 46 males). Of the samples collected on the whelping patch, 35 (94.6%) were empty, accounting for 31% of the total number of empty stomachs observed. The majority of food-containing stomachs (83.1%) were taken from the nearshore region along the northeast coast (Table 4). Only 3 (5.5%) of the pup stomachs examined contained food. Food was found in 86 (55.1%) of 1+ stomachs (Table 5).

Table 6 presents a summary of food items encountered in the stomachs. A total of 19 prey groups were identified, 13 fish and 6 invertebrates. Greenland halibut represented the most abundant prey species, occurring in 53.9% of the stomachs examined. Arctic cod (Boreogadus saida) and capelin were also important prey items, found in 27% and 23.6% of the stomachs, respectively. Herring was found in 13.5% of the stomachs examined, while 11.2% of the stomachs contained redfish. Squid was found in 19.1% of the food-containing stomachs while 9.0% of the stomachs had unidentified fish.

Discussion

Prey Items

This study provides the first quantitative data available on the stomach contents of hooded seals off the coast of Newfoundland and Labrador. A large number of prey types were found in the stomachs examined indicating that hooded seals feed on a wide variety of prey.

By far the most prevalent prey species found in the stomachs examined was Greenland halibut, occurring in over half (53.9%) of the stomachs. Other species commonly found were arctic cod, capelin, squid, herring and redfish (in descending order of frequency of occurrence).

The prey consumed supports previous reports that hooded seals inhabit and feed in deep water areas. Both Greenland halibut and redfish are deepwater species; off northern Newfoundland/southern Labrador, Greenland halibut are usually found in depths in excess of 450 m (ranging from 90-1600 m). While redfish have been caught as deep as 1100 m, they are generally considered to remain on or near the bottom during daylight, rising in the water column at night to feed (Scott & Scott 1988).

Herring, a pelagic marine species, are commonly found in the deep water bays of northeast Newfoundland (J. Wheeler, DFO St. John's, pers. comm.). Capelin and Arctic cod are also pelagic fish which are found at a variety of water depths (Scott & Scott 1988). All three species are abundant in the areas sampled and are readily available to hooded seals.

The harp seal (Phoca groenlandica) occupies a similar geographical habitat to the hooded seal. However, unlike hooded seals, harp seals appear to feed higher in the water column and/or closer to shore. The most frequently occurring food items in harp seal stomachs collected from the same region were Arctic cod (43.7%), and capelin (37.7%) (Ni, et al., unpublished data). In hooded seals, capelin and arctic cod occurred less frequently (27.0% and 23.6% respectively), while Greenland halibut were very common. In contrast, Greenland halibut were found in only 0.49% of the harp seal stomachs examined. This suggests that although harp seals and hooded seals share a common geographical range, the prey species consummed differ in relative importance.

Sufficient samples were not available to determine if temporal and geographical variations in prey occur. The majority (83%) of stomachs containing food were collected from the nearshore waters along the northeast coast of Newfoundland in March and April. The highly biased sampling reflects the distribution of hunting effort as well as the temporal distribution of hooded seals in the region.

A major limitation to using stomach content analyses is that the results are likely biased toward prey types whose hard parts remain longest in the stomach. The proportion of different prey species in the stomach will be influenced by the rate at which they are digested and pass through the stomach, as well as the proportions in which they were ingested (Harwood & Croxall 1988). An additional problem with the analysis of stomach contents is how to express the results. Frequency of occurrence values overestimates the importance of prey represented by hard parts (Hyslop 1980). Also, small, frequently occurring species appear to contribute more to the overall diet than larger, less abundant prey. In contrast the use of stomach content weights overestimate the importance of rare, heavy items and are affected by the degree of digestion rates of different prey.

It is difficult to compare the results obtained in the present study to other studies as there are no other quantitative data available; only common prey types were identified. As in this study, Kapel (1982) reported Greenland halibut, redfish, capelin, and gadoids (species unspecified), as important prey items. In Canadian waters, Sergeant (1976b) also reported that redfish and Greenland halibut were important prey species of hooded seals. With the exception of octopus and starfish, all prey items summarized by Reeves and Ling (1981) were present in stomachs examined in the present study.

Hooded seal-fisheries interactions

The impact of hooded seal food consumption on commercial fisheries yields is difficult to assess. Quantitative data on the type of prey species and size classes consumed, and geographic and temporal variations in diet must be obtained. Also, data on hooded seal distribution, population size, age structure, and age-specific consumption rates is needed. This study provides preliminary information on the prey species consumed. Data on prey size classes and possible temporal and geographical variations in diet are lacking. Population trends of hooded seals residing in areas of commercially important fish stocks are poorly understood, information concerning distribution outside of the reproductive period is limited, and time spent in Canadian waters is unknown. Little is known about consumption rates of of wild hooded seals.

The Royal Commission on Seals and Sealing in Canada (1986) attempted to estimate the potential impact of seals on commercial fisheries. It was estimated that hooded seals would consume approximately 4% of their body weight per day. Based on this value, a population of 300,000 hooded seals would consume approximately 1.5 tonnes of food annually. This is surely an overestimate as the calculations were based on an average weight of 350 kg. Kovacs and Lavigne (1986) report the averages weights of 300 kg and 160 kg for males and females, respectively. Allowing for the smaller size of immatures, the mean weight of the total population is likely to be less than 200 kg. Further, due to a lack of data on distributions of seals and relative feeding rates, the Royal Commission assumed that

consumption was evenly distributed among West Greenland (1A-F), Northern Canada (0,2G-H) and Southern Labrador/NE Nfld (2J,3K) areas. No allowance was made for the seasonal nor age-specific utilization of the different areas. For example, an unknown percentage of young seals do not appear to move south into 2J3K with the adults in the spring. Finally, the Royal Commission was hampered by the lack of quantitative data on prey of hooded seals in Candadian waters and had to rely upon data from Greenland (Kapel 1982). Demersal fish appear to be important in diet of hooded seals in both areas. However, Greenland animals did not appear to feed significantly on Arctic cod or capelin. Kapel (1982) did report the presence of Gadidaes which likely includes Arctic cod. However, combining all of the gadoids into a single group makes it impossible to determine the extent of feeding upon commercial vs non-commercial species and may have been responsible for the Royal Commission concluding that hooded seals may feed upon Atlantic cod.

Four of the five fish species occurring most frequently in the stomachs of hooded seals examined in this study are important commercial species; Greenland halibut, capelin, herring and redfish. Although estimation of interactions between hooded seals and these prey species cannot be quantified, areas of potential conflict can be determined. With the exception of the small number of hooded seals which breed in the Gulf of St. Lawrence, most are found primarly in NAFO subareas 2 and 3 where commercial fisheries exist for all four of the major prey species. Greenland halibut and redfish are commercially fished in deepwater areas of both subareas (Bowering et al. 1990, Atkinson, DFO St. John's, pers. comm).

Although the major herring fishery is in Subarea 4, they are harvested in Subarea 3 (3KL). This fishery is primarily a late fall inshore fishery along the northeast coast of Newfoundland, an area which appears to be frequented by hooded seals during the winter. Thus, there is the potential for competition between hooded seals and the fishery in this area.

Atlantic cod, the most important commercial fish in the region, was not a major prey item for the hooded seals examined during this study. Only 4 (2 from the nearshore area of the northeast coast, 1 from offshore (2J3KL), and 1 from the south coast), of the 89 hooded seals with food in their stomachs had eaten Atlantic cod. However, cod spawn in deep offshore waters in areas when hooded seals are present. Unfortunately, few samples were available from offshore areas. Hooded seals are caught incidentally in offshore trawls for cod, indicating some degree of direct interaction. Alternately, hooded seals may also affect cod indirectly through competition for capelin. However, hooded seals are only one of many marine predators of capelin. Given the relatively low occurrence of capelin in the hooded seal diet and their population levels, a significant impact upon cod is not likely.

In summary, this study indicates that hooded seals eat a wide variety of prey. Six main species appear to be taken by hooded seals: Greenland halibut, Arctic cod, capelin, squid, herring, and redfish. These findings correspond with previous studies (Sergeant 1976b, Kapel 1982, and Reeves and Ling 1981). Four of these species are commercially

important in the areas frequented by hooded seals. Due to the lack of knowledge concerning hooded seal consumption rates and distribution, the extent of any possible interactions cannot be estimated.

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Table 1. Frequency of occurence of prey items in the stomachs of hooded seals collected in Greenland waters 1970-1978, from Kapel 1982.

Stomach Contents	South Greenland 1970-78		Southeast Greenland 1970-74		Northwest Greenland 1972-78	
	No.	%	No.	%	No.	%
Fish						
Greenland Halibut	13	1.0	2	0.9	278	45.3
Wolffish	28	2.3	1	0.4	49	8.0
Redfish	101	8.2	24	10.2	6	1.0
Capelin	58	4.7	1	0.4	26	4.2
Gadidae	131	10.6	1	0.4	15	2.4
Other	15	1.2	-	-	22	3.6
Unidentified	482	39.0	1	0.4	5	0.8
Total	828	67.0	30	12.7	401	65.3
Squid	6	0.5	-	-	1	0.2
Crustaceans						
Decapods	14	1.1	-	-	4	0.6
Other	2	0.2	-	-	55	9.0
Total	16	1.3	-	-	59	9.6
With food	850	68.8	30	12.7	461	75.1
Empty	386	31.2	206	87.3	153	24.9
Total	1236	100.0	236	100.0	614	100.0

Table 2. Hooded seal stomach samples collected in Newfoundland and Labrador waters 1982 - 1990.

Month	NE Coast	Offshore 2J3KL	Labrador	South Coast	Whelping Patch
Jan.	2	6	-	-	-
Feb.	12	-	-	2	-
March	47	-	-	3	37
April	75	7	-	1	-
May	3	-	-	-	-
June	1	-	-	-	-
July	-	-	-	-	-
Aug.	-	-	-	-	-
Sept.	-	-	-	-	-
Oct.	-	-	1	-	-
Nov.	1	1	-	-	-
Dec.	2	-	-	-	-
Total	143	14	1	6	37

Table 3. Age structure of hooded seals sampled from Newfoundland and Labrador waters 1982-1990.

Area	Age 0	Age 1+	Total
Northeast Coast	52	91	143
Offshore 2J3KL	3	11	14
Labrador	0	1	1
South Coast	0	6	6
Whelping patch	0	37	37
Total	55	146	201

Table 4. Presence of food in hooded seal stomachs collected in Newfoundland and Labrador waters 1982-1990.

Area	Empty	With Food	Total
Northeast Coast	69	74	143
Offshore 2J3KL	5	9	14
Labrador	0	1	1
South Coast	3	3	6
Whelping patch	35	2	37
Total	112	89	201

Table 5. Presence of food in stomachs of hooded seals of various ages.

Age class	Empty	With Food	Total
Age 0	52	3	55
Age 1+	60	86	146
Total	112	89	201

Table 6. Contents of hooded seal stomachs collected in Newfoundland and Labrador waters 1982-1990.

Prey	Frequency of Occurrence N	%
Fish		
Greenland halibut	48	53.9
Arctic cod	24	27.0
Capelin	21	23.6
Herring	12	13.5
Redfish	10	11.2
Pleuronectidae	4	4.5
Atlantic cod	4	4.5
Gadidae	4	4.5
American plaice	3	3.4
Skates	3	3.4
Sculpins	3	3.4
Eelpouts	2	2.2
Wolffish	1	1.1
Unidentified	8	9.0
Invertebrates		
Squid	17	19.1
Shrimp	3	3.4
Amphipods	2	2.2
Euphausiids	1	1.1
Snow crab	1	1.1
Bivalve	1	1.1